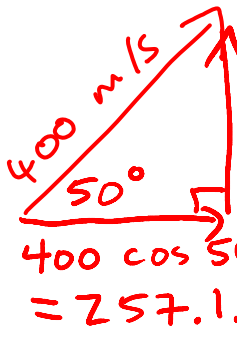
Example 5.
An artillery shell is fired over level ground, at 400. m/s and at an angle of 50° to the horizontal. Find:

(a) total time in the air.



$400 \sin 50 = 306.4 \text{ m/s}$

$400 \cos 50 = 257.1 \text{ m/s}$

Hor	Vert
$v_0 = 257.1$	$v_0 = 306.4$
$a = 0$	$a = -9.8$

→ to find total time, use vertical info, with $v = -306.4 \text{ m/s}$ (lands at same level with same speed down

$v = v_0 + at$

$-306.4 = 306.4 + -9.8t$

$$\boxed{t = 62.5 \text{ s}}$$

(b) how high the shell rises.

→ again, use vertical information; this time, use $v = 0$ (at max. height)

$v^2 = v_0^2 + 2ad$

$0 = 306.4^2 + 2(-9.8)d$

$$\boxed{d = 4.79 \times 10^3 \text{ m}}$$

(c) the location of the shell after 25.0 seconds.

→ first, find horizontal displacement:

$d = v_{av} t$

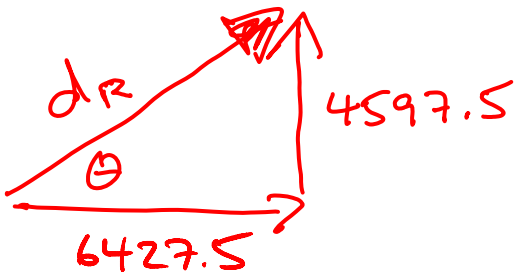
$= 257.1(25) = 6427.5\text{ m}$

→ then, find vert. displacement:

$d = v_0 t + \frac{1}{2} a t^2$

$= 306.4(25) + \frac{1}{2}(-9.8)(25)^2$

$= 4597.5\text{ m}$



$d_R = \sqrt{(4597.5)^2 + (6427.5)^2}$

$= 7902.5\text{ m}$

$\theta = \tan^{-1}\left[\frac{4597.5}{6427.5}\right] = 35.5°$

so $\boxed{d_R = 7.90 \times 10^3\text{ m} @ 35.5° \text{ up}}$

(d) the velocity at impact.

→ vertically, $v = 306.4$ m/s down

→ horizontally, $v = 257.1$ m/s (constant)

∴ velocity at impact must be the same as at launch:

$\boxed{400\text{ m/s} @ 50° \text{ down}}$

the range of the shell.

→ use total time + horizontal speed:

$$d = v_w t$$

$$= (257.1)(62.5)$$

$$\boxed{d = 1.61 \times 10^4 \text{ m}}$$